instruction manual

TELEDYNE ANALYTICAL INSTRUMENTS

Sensors • Analyzers • Systems

Scientific Solutions

830 CHESTNUT STREET, CITY OF INDUSTRY, CA 91749-1580 U.S.A. • (818) 961-9221 • (213) 283-7181 • TWX (910) 584-1887 • TDYANYL COID • FAX (818) 961-2538

TELEDYNE
ANALYTICAL INSTRUMENTS
16830 CHESTNUT STREET
P.O. BOX 1580
CITY OF INDUSTRY, CALIFORNIA 91749-1580 USA
TELEPHONES: (213) 283-7181 & (818) 961-9221
CABLE ADDRESS: TDYANALY
TWX: (910) 584-1887 TDYANYL COID
FAX: (818) 961-2538

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INSTRUCTION MANUAL

MAX 5

PORTABLE COMBUSTION EFFICIENCY MONITOR

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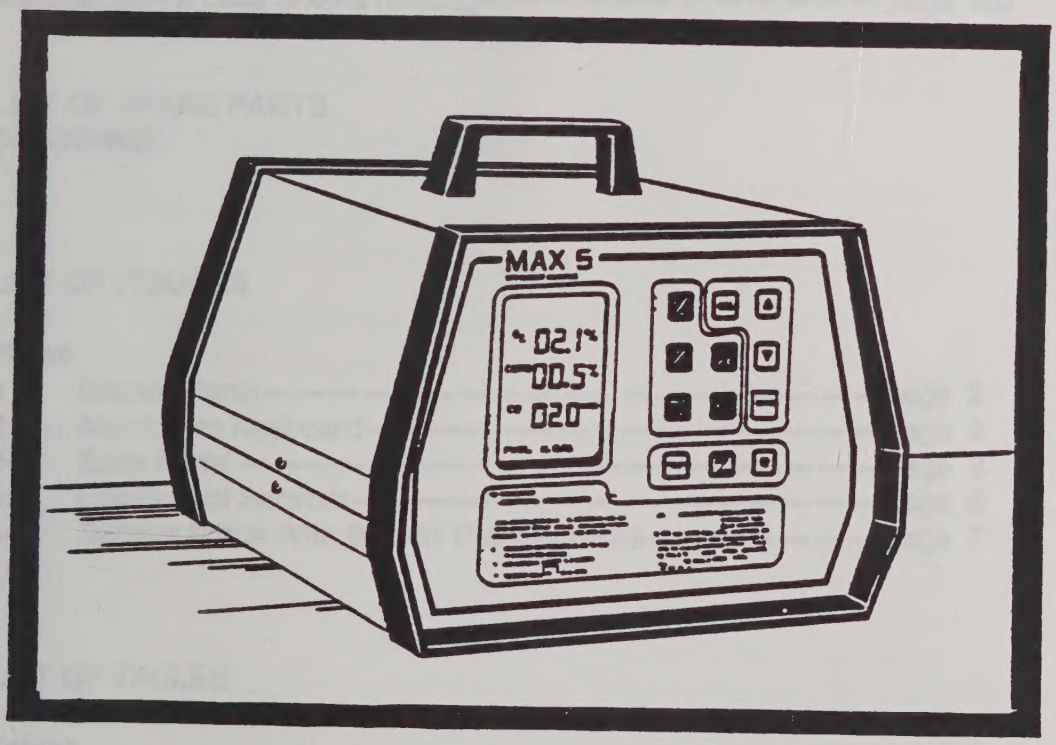

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CITY OF INDUSTRY, CALIFORNIA 91749-1580 USA
TELEPHONE (818) 961-9221, (213) 283-7181
FAX (818) 961-2538
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Rev. 7/89

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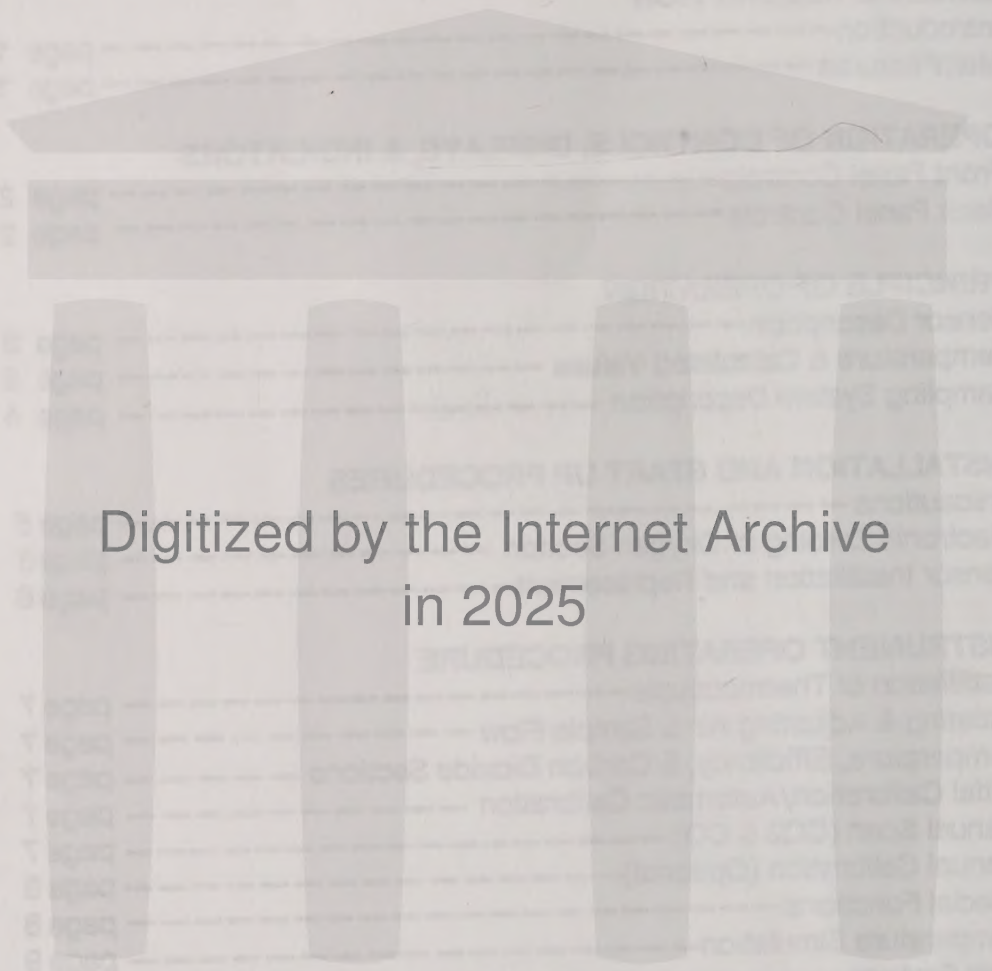

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MAX 5
PORTABLE
COMBUSTION EFFICIENCY
MONITOR

GENERAL DESCRIPTION

INTRODUCTION

The MAX 5 Portable Combustion Efficiency Analyzer provides several special features and applications. It directly measures oxygen, carbon monoxide, combustibles, and temperature levels in a subject sample stream. The MAX 5 also includes microprocessor-based special functions enabling the computer to calculate levels of carbon dioxide and combustion efficiency. As an added bonus, the computer can calculate and display actual fuel cost savings (Compu-Cents™), by using the efficiency level prior to an adjustment, the level after an adjustment, and an average fuel cost as reference points.

The MAX 5 incorporates an internal microcomputer. The computer program resides in ROM (read only memory) and is not affected by shutdown periods, loss of power, or battery failure. However, the calibration parameters and stored measurement readings are retained in RAM (random access memory) which requires operating power to protect it; thus, the information stored in RAM will be lost if battery power is interrupted (during battery replacement, for example).

The computer controls the display and reads the keyboard. A 12-bit analog-to-digital (A-D) converter converts the output signals from the various measurement sensors and the thermocouple into digital data that goes to the computer. The computer interprets this and compares the data to calibration data you have entered. The computer displays the corrected values on the LCD.

Also, the computer performs error checking and reporting, as well as the other special functions available for selection via the special function keys.

The actual program that runs the computer is compiled into machine language for faster execution and more efficient use of memory. It is not accessible by high-level interpreters, such as Basic, and it is not available to the user for modification in any way.

MAIN FEATURES

1. Auto Zero. MAX 5 offers automatic zero calibration for carbon monoxide and combustibles and automatic span calibration for oxygen. Also, you can adjust them manually. You have to adjust the span calibration manually for carbon monoxide and combustibles.

2. Stored Readings. The computer stores up to 20 sets of readings and reports them to the LCD (Liquid Crystal Display) or to an optional serial printer.

3. Computer Memory. A 16-bit microprocessor and 40 kilobytes of memory are standard.

4. ROM Instruction Manual. The MAX 5 stores an abbreviated but complete instruction manual in ROM and prints the manual upon request.

5. Rechargeable Batteries. Nickel-cadmium batteries provide power to the unit for up to 8 hours of continuous operation. You recharge the batteries by plugging a standard power cord into a 115V receptacle. TAI also offers 220V and 100V versions.

6. Proven Sensors. The MAX 5 uses Teledyne's standard line of sensors, already proven to be among the best in the instrumentation industry.

7. CO Analysis. Four ranges of CO analysis are available for the MAX 5; one standard 0-1000 ppm CO and three optional ranges - 0-500 ppm CO, 0-1% CO and 0-2.5% CO.

OPERATION OF CONTROLS, DISPLAYS & INDICATORS

Initial Display. Shortly after it is first switched on, the computer will test all its internal functions and then automatically enter its normal operating mode. During this time, it will display random segments on the LCD.

Temperature Display. Readings below 1000 degrees (Fahrenheit or centigrade) are read directly (for example, 100 means 100 degrees). If a reading is over 1000 degrees, it will be displayed as a number with two decimal places, and you must multiply by 1000 to get the actual temperature. For example, 1.50 means 1.50 x 1000, or 1500 degrees.

Display Panel. A continuous updated LCD monitors O2, CO, CO2, Combustibles, Temperature, & Net Combustion Efficiency. The membrane keyboard includes all needed controls to select functions; display three parameters at once, control the sampling pump, and choose degrees Centigrade or Fahrenheit as shown in Figures 1 & 2.

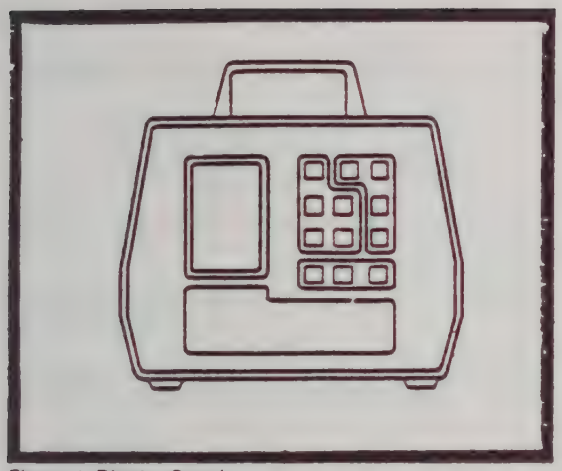


Figure 1. Display Panel.

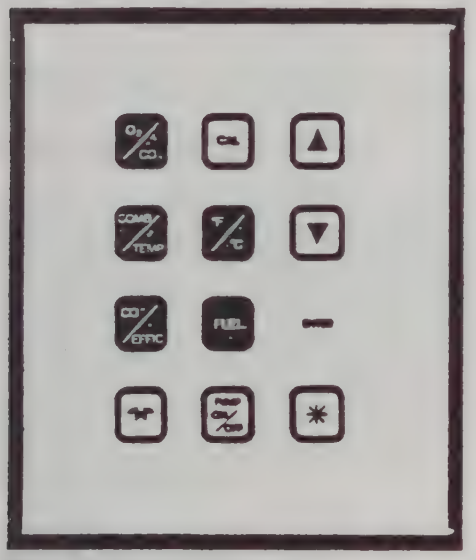


Figure 2. Membrane Keyboard.

FRONT PANEL CONTROLS

Temp Key (°F or °C). This key, when pressed, determines which of the two available temperature scales (toggles between degrees Fahrenheit or degrees Centigrade) will be used to display temperature readings. See "Initial Calibration/Automatic Calibration" - 'Temperature.'

O2 / CO2. Because both the oxygen and carbon dioxide readings occupy the top row of the LCD, you press this key to display one or the other. To get a valid CO2 reading, you must select the proper fuel (see "FUEL" below).

COMB / TEMP. You select either the combustibles or the temperature readings for display by pressing this key. The readings appear in the center row of the display.

CO/EFFIC. You press this key to toggle between the carbon monoxide and calculated efficiency readings. The readings appear in the bottom row of the display.

FUEL. This key is primarily used for CO2 calculation and efficiency readings. You must choose one of the four pre-selected fuels (#2 fuel oil, #6 fuel oil, natural gas, or solid fuels such as coal) so that the computer calculations will be valid. Pressing the FUEL key causes the fuel selection (across the bottom of the display) to toggle through the four selections. When you see the fuel that you are using, simply leave it that way, and the calculations will be valid for that fuel.

CAL. Calibration is automatic for O2. MAX 5 also includes auto-zeroing for Carbon Monoxide (CO) and combustibles, so the user need only set the spans. Calibration settings remain in memory even when the power is off.

TELEDYNE LOGO . Used to exit from calibration procedures and used in conjuction with calibration functions.

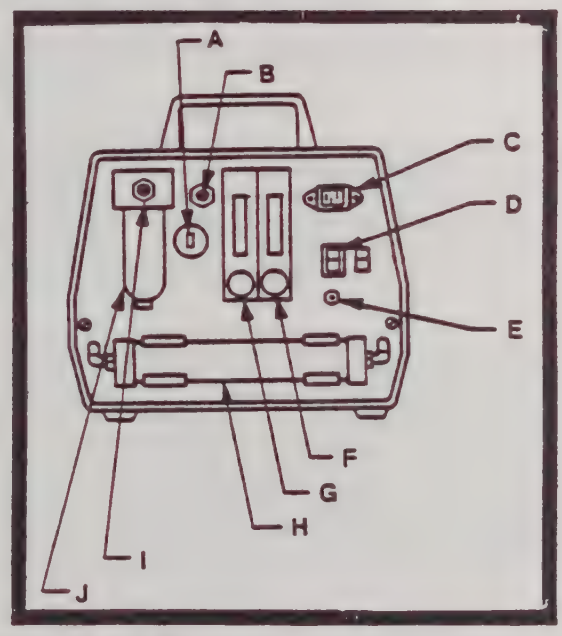


Figure 3. Back Panel.

BACK PANEL CONTROLS

A. Thermocouple Connection for type "K" thermocouple supplied in probe (type "J" optional).

B. Vent.

C. AC Power connection for recharging NiCad batteries, which provide up to eight hours of operation.

D. Battery Power ON-OFF switch.

E. RS-232-C Serial output to provide:

* short-form Operations Manual
* up to 20 sets of stored data
* continuous flow of all six readings

F. Air Flowmeter with flow set valve to regulate air flow.

G. Sample Flowmeter with flow set valve to regulate sample flow.

H. Chemical Scrubber for removal of corrosive compounds, such as SO2, H2S, and NOx.

I. Sample-In Port.

J. Coalescing Filter (to remove particulates and water) and filter-drop out pot.

PRINCIPLE OF OPERATION

SENSOR DESCRIPTION

Oxygen. The oxygen section uses Teledyne's Micro-Fuel Cell, Class B-3 oxygen sensor (U.S.Patent No. 3,429,796). The B-3 Micro-Fuel Cell measures the concentration of oxygen in a gas stream. The analysis is specific for oxygen; i.e. the measuring cell will not generate an output current unless oxygen is present in the sample gas. Therefore, the oxygen channel has absolute zero, and no zero gas is required to standardize the analyzer. The standard range is 0-25% oxygen, and you perform span calibration with atmospheric air as the span gas, where feasible.

Carbon Monoxide. The class F-1R* solid-state electrochemical sensor measures CO. The solid-state design eliminates leakage. You zero the CO section against air and span with a span gas that contains the measured component in a concentration equivalent to 80-90% of the instrument's maximum fullscale value. TAI sets the standard measurement range at 0-1000 PPM.

Combustibles. The combustibles sensor is a low-temperature, catalytic bead type transducer in a constant current-excited Wheatstone Bridge circuit. Two legs of the bridge are exposed to the sample gas. The other two legs are passive elements.

Gas diffuses into the sensing element and oxidizes at the catalytic surface of the active or measuring bead, causing its temperature to rise. The reference bead is not catalytically coated, so it is not heated by the combustibles. The difference in temperature and therefore resistance of the otherwise matched pair of catalytic beads creates a signal in the bridge circuit.

Use of the uncoated reference bead compensates for the effects of temperature variations, humidity changes, ambient pressure changes, and variations in line resistance. The beads are installed in a housing that has a flashback arrestor screen at the sensing aperture to prevent flame propagation into the process.

The combustibles readout is expressed in percentage LEL (methane equivalents). Air is the zero gas, and the span gas follows the 80-90% fullscale rule. By far the most common range is 0-5% methane equivalence (0-100% LEL), and the span gas for that range would be 3% to 4% methane in nitrogen. In other cases, a hydrogen and carbon monoxide mixture might be used. In the presence of catalyst poisons, the combustibles sensor will hold its sensitivity to a hydrogen/CO mixture far longer than to methane; therefore, it is important to calibrate it with the right mixture.

TEMPERATURE AND CALCULATED VALUES

Temperature. The MAX 5 uses a type "K" thermocouple. The temperature section includes circuitry and software to linearize the thermocouple signal and provide a zero-point reference. The temperature display reads in degrees Centigrade or degrees Fahrenheit depending on which temperature you select.

Carbon Dioxide. Because carbon dioxide is a combustion product, and its concentration level at any given time depends on how completely a given fuel is burned and its by-product of carbon monoxide is oxidized, the computer is able to calculate the carbon dioxide level. The oxygen and combustibles section readings and the fuel type you selected at the front panel are factors in the calculation resulting in the carbon dioxide concentration on a dry basis.

Efficiency. The computer calculates the efficiency level. The reading, calculated from the temperature and oxygen readings and the type of fuel selected, is not absolute; rather, it is a relative indication of the degree of improvement achieved by adjusting the burner. The efficiency is based on British Standards recommendations and is calculated from this formula:

$$\text{Efficiency} = 100 - K3 - \frac{K1 \times T}{K2 \times (1 - \frac{O2}{21})}$$

** US Patent No. 4,477,403; UK Patent No. GB2140556B; France Patent No. 2546626.*

Where T = net temperature oC

O2 = oxygen concentration %

K1 = fuel factor on hydrocarbon composition

K2 = theoretical maximum CO2 concentration of flue gas

K3 = correction factor for latent heat ("wet" losses)

The values of K1, K2 and K3 for the four fuels covered by the MAX 5 are:

	K1	K2	K3
Natural gas	0.38	11.8	11.0
#2 oil	0.56	15.6	6.0
#6 oil	0.6	15.9	5.0
Coal	0.63	18.6	3.0

SAMPLING SYSTEM DESCRIPTION

The analyzer should be inspected and calibrated each time it is used. This includes inspecting the filter/water trap and scrubber, checking the condition of the batteries, and calibrating the instrument.

The sample gas and the ambient temperature must be between 32° and 122°F (0° to 50°C) for the temperature compensation to operate properly. For maximum accuracy, the analyzer should be calibrated at the same pressure, flow rate, and temperature anticipated in the sample gas. To minimize water condensation in the instrument, the sample gas temperature should be approximately the same as the ambient temperature of the analyzer. The sample gas temperature should never be more than 10°F (5°C) above the analyzer temperature.

The flue gas sample must be sufficiently cooled before it enters the analyzer. The sample probe supplied will do this. Alternately, for the highest temperature application, a length of 1/4" metal tubing (normally stainless steel) approximately 10 feet long will generally be satisfactory.

Measurement accuracy can be affected by abrupt changes in the ambient temperature. If possible, place the analyzer in the environment where it will be used for at least one hour before operation. This permits temperature stabilization of the thermistor and oxygen cell. Or, if desired, recalibrate the oxygen analyzer section in the environment where it will be used.

All sample line tubing and fittings must be leak-free. Air entering the sample line under pump suction can dilute the sample gas to a point where errors in readings will result. The sample line can be connected to the analyzer with a short section of tubing.

Note: Certain types of plastic tubing (e.g. silicone tubing) contain plasticizers which can leach from the tubing and cause readings on the combustibles section of the analyzer, and in extreme cases damage the combustible sensor.

If too short a sample line is used, the sample gas may not have sufficient time to cool, resulting in water being condensed into the analyzer sampling system. The introduction of liquid water into the system can damage the pumps and/or temporarily affect performance of the oxygen sensor (cause erroneous readings, etc.) and certain other components.

If the flue gas sample contains more water than the condensate trap can reasonably handle, it may be necessary to install a larger trap upstream of the sample intake into the analyzer.

If span gas is connected to the analyzer sample intake without the pumps operating, "coking" (or carbonizing) of the combustible sensor will occur. In most cases, the concentration of any particular compound you expose the combustibles sensor to should not exceed the LEL (Lower Explosive Limits) of that compound.

Response factors have been determined to relate the sensor output of a specific compound to the output obtained using methane. Table I shows a list of some typical compounds and their LEL (Lower Explosive Limits) values. To determine the output of the sensor to any of the gases listed, compared to the same concentration of methane, multiply the MAX 5 reading obtained by the factor listed. For example, if the output is calibrated with methane at 2%, the output for ethylene at 2% would be 2.0% X 1.26 = 2.52% methane equivalent.

If you want to establish a reading for a particular gas, you can calibrate with that gas. Alternately, you can calculate what the Methane equivalency is for that particular gas and calibrate the instrument with Methane, but make it read as if it were exposed to the gas of interest. For example, if you calibrate with Methane and the MAX 5 reads 3%, but Propane would read 4%, you calibrate with Methane and adjust the MAX 5 to read 4%.

TABLE I

DETECTOR RESPONSE TO GASES

COMPOUND	LEL*	RESPONSE FACTOR
Methane	5.0	1.00
Hydrogen	4.0	0.86
Carbon Monoxide	12.5	0.32

(continued next page)

(TABLE I - cont.)

COMPOUND	LEL*	RESPONSE FACTOR
Ethane	3.0	1.20
Ethylene	2.7	1.26
Acetylene	2.5	1.39
Propane	2.2	1.42
Propylene	2.0	1.33
Butane	1.9	1.54
Hexane	1.1	1.50
Cyclohexane	1.3	1.44
Heptane	1.05	1.59
Benzene	1.3	1.50
Pentane	1.5	1.45
Toluene	1.2	1.48
Ethylene Oxide	3.6	0.76
Methyl Ethyl Ketone	1.8	0.96
Methyl Acrylate	2.8	0.59

*Taken from Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids, National Fire Protection Agency.

To determine the concentration of a compound present at the sensor from the MAX 5 reading, when calibrated with Methane, divide the MAX 5 reading (in percent Methane) by the factor. For example, if Ethylene is flowing by the sensor, and a MAX 5 reading of 2.0% is obtained, the concentration of Ethylene would be:

$$\frac{\text{MAX 5 Reading}}{\text{Factor}} = \frac{2.0\%}{1.26} = 1.59\%$$

For Hydrogen:

$$\frac{2.0}{.86} = 2.32\%$$

For Carbon Monoxide:

$$\frac{2.0}{.32} = 6.25\%$$

For a mixture of 70% Hydrogen and 30% Carbon Monoxide:

$$0.7\left(\frac{2.0}{.86}\right) + 0.3\left(\frac{2.0}{.32}\right) = 3.5\%$$

CAUTION

In most cases, the concentration of any particular compound that the sensor is exposed to should not exceed the LEL of that compound, or sensor damage could occur.

The concentration of combustibles should never exceed that which will react completely with the available oxygen present in the sample (stoichiometric burning), otherwise "coking" (the deposition of carbon from incomplete combustion) will occur at the sensor, and drift and a loss of sensitivity will result.
Note: For compounds not listed in Table I, consult Teledyne Analytical Instruments.

Because of the electrochemical properties of the B-3 oxygen cell, the MAX 5 is designed for spot checking, not continuous on-line application. The maximum continuous sampling period should not exceed 30 minutes, followed by a 30-minute purge with atmospheric air.

INSTALLATION AND START-UP PROCEDURES

Upon receipt, of the MAX 5, inspect the entire unit for damage. If damage is found, notify the shipper. Check unit, and included accessories, for broken or loose parts. DO NOT CONNECT THE INSTRUMENT UNTIL ALL INSTRUCTIONS HAVE BEEN READ! If damage is not found, check for the following parts:

* Probe
* Power Cord
* Sensors - F-1R - blue label, B-3 - orange label. (The Combustible sensor is factory installed).
* Instruction Manual
* Calibration Kit - Optional, however, required for calibration purposes.
* Printer (optional)
* Printer Interface (with printer option)
* RS-232 Module (with printer option)

PRECAUTIONS

1. Do not press on the sensing surface (membrane) of the Micro-Fuel Cell sensor. Puncturing or other damage will require replacement of the sensor.

2. The F-1R and Micro-Fuel cell sensors contain a caustic mixture, which is harmful if touched, inhaled, or swallowed. In case of eye contact, immediately flush eyes with water for at least 15 minutes. Call a physician. See Material Safety Data Sheets (MSDS).

3. The PURAFIL Media Scrubber contains Potassium Permanganate. PURAFIL Media is non-toxic upon oral, dermal, and inhalation exposure. Breathing of the dust may cuase sneezing. Skin may feel dry after contact. PURAFIL Media is an eye irritant. In case of eye contact, immediately flush eyes with cold water for at least 15 minutes. Call a physician immediately. See Material Safety Data Sheet (MSDS).

4. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case, the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

4. DO NOT RUN UNIT OFF AC POWER. UNIT IS MADE FOR PORTABLE APPLICATION – NOT CONTINUOUS LINE APPLICATION!

ELECTRONIC ZEROING OF OXYGEN SECTION

1. Turn power switch on. If a negative O2 reading is displayed proceed to step 2. If a negative reading is not displayed, turn off unit and proceed to "Sensor Installation/Replacement" section.

2. Press the CAL and LOGO keys simultaneously. CAL will display on the screen.

3. Press the CAL key.

4. Press the CAL, UP and DOWN keys simultaneously. A double beep will occur followed by a short interval and a second double beep. Electronic zeroing is now completed.

SENSOR INSTALLATION AND REPLACEMENT

To install (or replace) the sensors in the MAX 5, proceed as follows:

1. Unplug the charging cord from the analyzer and turn power switch off. Then, loosen the two screws (no more than 3/4") indicated on the back panel of the MAX 5.

2. Remove the upper screws on each side of the MAX 5 case and lift the cover off the unit.

3. Remove the finger nuts and bracket holding the sensors in place.

Note: As you face the unit (keyboard toward you) the combustibles sensor is on the far left, the CO sensor is in the center, and the oxygen sensor is on the right as shown in Figure 4.

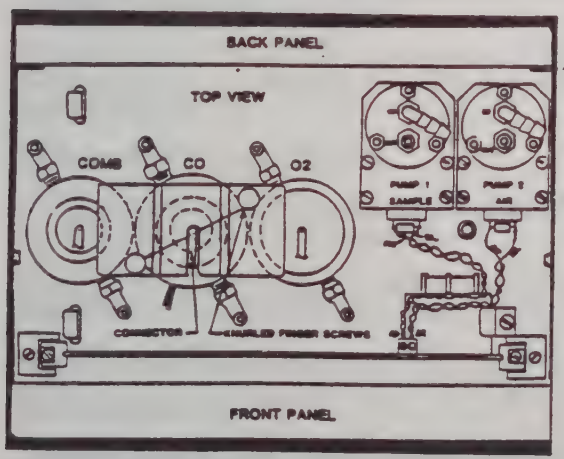


Figure 4. Location of Sensors.

CO SENSOR : (Refer to Interconnection Diagram)

a. Installation: To install the F-1R sensor, remove the sensor from its protective bag and plug it into the center receptacle in the bottom of the MAX 5. Next, take the connector from J6 on the analog board and plug it into the top of the F-1R sensor.

b. Replacement: To replace the F-1R sensor, unplug the connector from J6 at the top of the sensor, remove the sensor by pulling up on it, and throw away the old sensor. Take a new F-1R sensor from its protective bag, insert it into the receptacle (center bottom of the MAX 5), and attach the connector from J6 to the top of the sensor.

OXYGEN SENSOR : (See Interconnection Diagram)

CAUTION

Do not scratch, puncture, or otherwise damage the Micro-Fuel Cell membrane (screen surface). Damage to the membrane will require sensor replacement. NEVER PRESS ON THE SENSING SURFACE (screen); you might damage the sensor.

a. Remove the sensor from its protective bag. Carefully remove the shorting clip.

b. Pull up on the oxygen sensor holder (on the right), place the Micro-Fuel Cell (membrane side down) onto the surface under the sensor holder, and place the sensor holder over the cell. Be sure that the sensor is connected to J5 on the analog board.

COMBUSTIBLES SENSOR (Replacement Only): (See Interconnection Diagram)

a. The combustibles sensor is connected to J4 on the analog board. If the sensor is not connected to J4 or is not present, connect it to J4 or find it in the shipping carton. Then, remove the protective bag, connect it to J4, and plug it into the receptacle in the bottom left side of the MAX 5.

b. To replace the combustibles sensor, remove the existing sensor from the receptacle, detach the connector from the sensor, and throw away the old sensor. Remove the protective bag from a new sensor, connect the sensor to J4, and then plug the sensor into the receptacle.

7. Replace the bracket over the sensors, insert the finger nuts, and tighten them to secure the bracket.

8. Replace the cover, insert and tighten the side screws, and tighten the screws on the back panel.

9. Allow the unit to charge overnight to stabilize the sensors and to obtain a full charge. CAUTION: POWER SWITCH MUST BE IN THE OFF POSITION!

INSTRUMENT OPERATING PROCEDURE

INSTALLATION OF THERMOCOUPLE

1. Plug the thermocouple connector into the back panel jack (for initial calibration) as shown in Figures 3 & 5.

2. Turn the power switch on and allow the readings to stabilize for approximately 30 seconds.

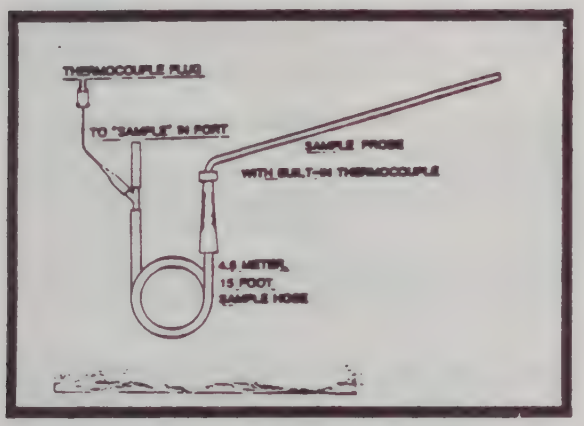


Figure 5. Sample Probe With Built-In Thermocouple.

INITIATING AND ADJUSTING AIR AND SAMPLE FLOW

CAUTION

The analyzer is intended to operate at atmospheric (14.7 psi) or near-atmospheric pressure. If the analyzer is subject to high positive pressures, damage may occur to the pumps or other flow systems. A regulator may be necessary upstream to maintain sample pressure at or below atmospheric level, if you want to use this analyzer to measure a high pressure sample.

1. Connect the probe sample line to the inlet port of the analyzer, being sure that the exhaust port is vented to a safe area.

2. Press the PUMP ON/OFF key.

3. Adjust both flowmeters (on back panel) at 2 scfh for standard range (0-1000 ppm CO).

NOTE: For 0-2.5% CO range: Adjust the sample flowmeter to .75 scfh; set air flowmeter at 2 scfh.

4. After measuring a sample gas (not more than 30 minutes), expose the inlet port to clean dry air (be sure the pumps are still on).

5. Purge with atmospheric air for an amount of time equal to the operating time. If water appears at the vent, purge until water no longer appears.

CAUTION

To avoid sucking in water, turn off the pumps before opening the filter drain.

6. Empty the water condensate trap, as required. If necessary, replace the filter element.

TEMPERATURE, EFFICIENCY and CARBON DIOXIDE SECTIONS

Carbon dioxide and efficiency levels are calculated; no calibration or adjustments are necessary here. The thermocouple section may be calibrated if desired.

INITIAL CALIBRATION and AUTOMATIC CALIBRATION (carbon monoxide and combustibles zero, oxygen span)

1. Press the LOGO and CAL keys simultaneously. "CAL" will appear on the LCD.

2. Press ENTER for autocal; "AUt O CAL" will appear on the LCD. When all readings are stable, a beep will sound. Press the LOGO key to exit autocal, if desired.

NOTE: If any negative readings appear, press the LOGO key to exit autocal. Proceed to the "Manual Calibration" section.

MANUAL SPAN (carbon monoxide and combustibles span calibration)

CAUTION: ADJUST SPAN GAS PRESSURE REGULATOR TO MINIMUM FLOW RATE (2-3 scfh) BEFORE CONNECTING TO ANALYZER.

NOTE: To perform manual spanning of the MAX 5 the Calibration Kit is required. The calibration kit consists of 3 gases; 2 calibration (CO & Combustible) and a background (nitrogen)

1. For Carbon Monoxide (CO) Span:

a. Run span gas through the analyzer; adjust the span gas pressure regulator until the analyzer's flowmeter indicates 2.0 SCFH. NOTE: This if for standard range only (0-1000 ppm). Set as required for optional ranges (0-1% and 0-2.5%)

b. Press the LOGO and CAL keys simultaneously, followed by CO/EFFIC, and ENTER. A number will appear in the CO section of the LCD.

c. When the number stabilizes, use the arrow keys to change the reading, as necessary, to agree with the span gas concentration marked on the tank. When the reading is correct, press ENTER to store

the value.

d. If the reading is very unstable, the LCD will display "bAd".

2. **For Combustibles Span**: (Standard) (0-5% Comb. - % CH4)

a. Run span gas through the analyzer; adjust the span gas pressure regulator until the analyzer's flowmeter indicates 2.0 SCFH. Make sure the air flowmeter also reads 2.0 SCFH.

b. Press the LOGO and CAL keys simultaneously, followed by COMB/TEMP and ENTER. A number will appear in the COMB section of the LCD.

c. When the number stabilizes, use the arrow keys to change reading as necessary, to agree with the span gas concentration (marked on tank % CH4). When the reading is correct, press the ENTER key once again to store the value.

d. If the reading is very unstable, refer to "Operator's Checks and Adjustment" section.

3. **Temperature**: (Optional) If calibration of the temperature probe is desired then press CAL and LOGO keys simultaneously, followed by the F/C key. The current temperature reading is displayed with the word ZERO in the upper left corner. The reading may now be changed using the arrow keys to a known temperature. Calibration is now completed!

NOTE: In the ZERO mode upward adjustment of reading may be limited to a few degrees.

To store reading press ENTER. The word SPAN will light up on top of the LCD. For span calibration a known higher temperature input would be required or changes to the low temperature. So if span calibration is not desired press ENTER to return to normal operation.

NOTE: Centigrade readings are automatically stored in memory. To store Fahrenheit readings, press COMB/TEMP key, then press °F/°C key.

MANUAL CALIBRATION (OPTIONAL)

(For Oxygen Span, CO and Combustibles Zero)

NOTE: If automatic calibration is not desired, the following manual calibration procedure applies.

NOTE: All references to zero gas during calibration means clean ambient air.

1. **Oxygen Span:**

Press LOGO and CAL at the same time, then the "O2" key. A number will appear in the "O2" section of the LCD; use the arrow keys to increase or decrease the reading as necessary to agree with the span gas concentration (usually air at 20.9% oxygen). Press ENTER to store the value and return to normal operation.

2. **Combustibles:**

Press LOGO and CAL simultaneously, then COMB. The LCD will display the current combustibles reading and the word "ZERO" at the top. Expose the combustibles sensor to its zero gas and use the arrow keys, as needed, to adjust the reading to the zero gas concentration (usually zero). To accept the value press ENTER. SPAN is displayed at the top of the LCD display. Run combustibles span gas through the instrument; use the up or down arrow to adjust the number displayed on the LCD to match the concentration marked on the tank (% CH4), if required. Press ENTER to store the value and return to the operating mode.

3. **Carbon Monoxide:**

Press LOGO and CAL at the same time, then CO/EFFIC The LCD will display the current carbon monoxide reading and the word "ZERO". Run zero gas through the analyzer; use the arrow keys, as needed, to adjust the reading to the zero gas concentration (usually zero). To store and proceed to manual span calibration, press ENTER. SPAN & WAIT is displayed at the top of the LCD. Run carbon monoxide span gas through the instrument; use the up or down arrow keys to adjust the number displayed on the LCD to match the concentration marked on the tank (PPM CO), if required. Press ENTER (after WAIT message disappears) to store the value and return to the normal operating mode.

To restore the built in temp. calibration constants press the CAL and LOGO keys simultaneously, then press °F/°C key. Press the CAL and COMB/TEMP keys simultaneously. This restores the proper values and exits the calibration mode.

SPECIAL FUNCTIONS

To activate the other special functions press both the arrow keys simultaneously. The LCD will show:

1 2 3

4 5 6

7 8 9

The numbers 1 thru 9 represent the nine keys on the keypad. The "1" above represents the "O2/CO2" key, the "9" represents the "ENTER" key, etc. The keys 1 thru 9 correspond to the special functions below.

TEMPERATURE SIMULATION

If the thermocouple probe is disconnected or bad the display will show "OPt", and "CELL FAIL" at the bottom, when temperature mode is selected. If a temperature simulation is desired press the F/C key. The "OPt" is replaced by a simulated temperature reading. To change the temperature press LOGO and CAL keys simultaneously, followed by F/C (this key toggles between °F & °C). The simulated temperature is displayed. Use the arrow keys to change reading, as desired. To store reading and return to normal mode press ENTER.

COST SAVINGS
(keys 1 and 2)

1. Press CO/EFFIC key to display efficiency on the LCD.

2. Activate Special Functions.

3. Press O2/CO2 (number 1 above); instrument will store measurement and return to the operating mode for burner adjustment.

4. Adjust the burner for optimum conditions.

5. Press arrow keys again to resume Special Functions; then press key 2.

6. The display will read "5 0 0"; adjust with arrow keys to represent three significant figures of an average fuel expense over some period of time. Press ENTER; the top line of the display will show the fuel savings. The second line will show the efficiency before adjustment, and the third (bottom) line will show the current efficiency. Press any key to return to normal operation (previous operation will resume).

To STORE current readings
(key 3)

1. Activate Special Functions.

2. Press key number 3; the display will read "5 0 0".

CAUTION: If you press ENTER while the display reads "0 0 0", you will ERASE all previous readings. To abort the erasing feature, simply press the LOGO key instead of ENTER.

3. Set the display to an ID number (1 to 999 settable) using the arrow keys.

4. Press ENTER to store the reading and the I.D. number (or Teledyne key to exit). Normal operation will resume.

5. The readings of up to twenty burners can be stored by the above method by selecting an I.D. number for each. Multiple readings under one I.D. number are OK (up to 20 readings total). All 20 readings and ID no.'s can be printed under function 5.

To DISPLAY readings that have been stored (key 4)

1. Activate Special Functions

2. Press key #4. The instrument will display the first I.D. number. Press the LOGO key to escape; any other key to proceed. The instrument will display the first set of readings. Press any key except the LOGO key to display the second set of readings and repeat for all readings. Press the LOGO, PUMP ON/OFF, and * keys to return to normal operation.

To PRINT stored readings
(key 5) (Optional - See Appendix)

1. Plug the printer cable into the Max serial port and the printer. Turn on the printer.

2. Activate Special Functions and press key #5. The printer will print the I.D. number and the six numerical values of each of the stored readings in chronological order.

To TEST the keyboard/LCD/RESET
(key 6)

1. Activate Special Functions

2. Press key 6 to call for a keyboard test.

3. To test, press any key other than the LOGO or ENTER keys; to resume normal operation press the LOGO key.

4. To perform a total memory reset press the ENTER key twice in succession.

AUTOMATIC DATA OUTPUT
(function 7)

1. Activate Special Functions.

2. Press key 7 to activate the Data Output function.

3. Press the up or down arrow as needed to cause the display to read the desired time interval (002 to 999 seconds) between reports. Press ENTER. A report is a continuous transmission, through the serial port, of all six data factors (measurements and calculations).

4. To stop data output, repeat steps 1 & 2 and set the time interval in step 3 to "000" followed by the ENTER key.

To PRINT an instruction manual (key 8)

1. Connect a serial printer to the instrument's serial port. Turn on the printer and switch it "on-line".

2. Activate Special Functions, then press key 8.

3. This abridged version of the instrument's instruction manual will be printed.

To check the VERSION of your instrument's software (key 9)

1. Activate Special Functions.

2. Press key number 9.

3. The display will show the model number and the month on the first line, the hour and the date on the second line, and the year on the third line. The model, month, day, and year correspond to the date of software release.

4. Press any key to resume normal operation.

ELECTRONIC ZEROING OF OXYGEN SECTION

1. Turn power switch on (without O2 sensor installed). If a negative O2 reading is displayed proceed to step 2. If a negative reading is not displayed, electronic zeroing is not required.

2. Press the CAL and LOGO keys simultaneously. CAL will display on the screen.

3. Press the CAL key.

4. Press the CAL, UP and DOWN keys simultaneously. A double beep will occur followed by a short interval and a second double beep. Electronic zeroing is now completed.

ROUTINE MAINTENANCE

WARNING: THE ELECTRONIC COMPONENTS IN THE MAX 5 CAN PRESENT AN ELECTRICAL SHOCK HAZARD. BEFORE REMOVING THE ANALYZER COVER FOR ANY REASON, DISCONNECT THE CHARGING CORD FROM THE POWER SOURCE AND THE ANALYZER.

SCRUBBER

The analyzer needs the scrubber to remove interfering gases, such as sulfur and nitrogen oxides, or hydrogen sulfide. These gases can cause false readings if they are not removed from the flue gas sample. The scrubber is disposable and must be periodically replaced.

Replace the scrubber when its granules have changed color from purple to gray. When all traces of purple are gone, the scrubber is not operating effectively.

To replace the scrubber, proceed as follows:

1. Obtain a new scrubber.

2. Carefully pull the old scrubber out of its bracket holder on the back of the unit.

3. The scrubber is attached to tubes on both sides; remove each end of the scrubber from the end of each tube and throw away the old scrubber.

4. Take the new scrubber out of its plastic bag and carefully attach the scrubber to each tube.

5. Feed the tubes into the analyzer very slowly as you insert the new scrubber into its bracket holder.

Note: You must be careful not to crimp the tubes when you replace the scrubber. You may want to open the MAX 5 to check the tubing the first time you replace the scrubber. To open the MAX 5, loosen the screws on the back, remove the top screws on the case, and lift the hood off the unit.

BATTERY RECHARGING

The rechargeable Nickel-Cadmium batteries need to be recharged after about 8 hours of use.

To Recharge the Batteries:

1. Turn the back panel power switch off.
2. Plug the power cord (connector end) into the back panel AC power receptacle and plug the other end into the correct voltage outlet.
3. Allow the batteries to recharge for the required line power:

100VAC, 50/60 Hz - 24-30 hrs.
115VAC, 50/60 Hz - 14-16 hrs.
230VAC, 50/60 Hz - 14-16 hrs.

BATTERY REPLACEMENT

Rechargeable Nickel-Cadmium batteries last for many years; however, you may need to replace them after a period of time. Before you replace the batteries, perform the following tests (make sure the MAX 5 is unplugged from the wall):

To Test the Power Supply (charging circuit):

1. Open the MAX 5 as instructed in Steps 1 and 2 under the "To Replace Batteries" section below.

2. Locate R39 resistor.

3. Put test meter leads across R39 resistor. The reading should be 40 mVDC + 2 mVDC when you plug the AC power cord into the wall.

4. If you get the correct reading in step 3, this indicates that the charging circuit is okay.

To Test the Batteries:

1. Unplug the MAX 5 from the wall.

2. Put the red lead from the test meter to J2 pin 1 (red) and the black lead to J2 pin 2 (green). The reading should be approximately 7.5 VDC. Move red lead to J2 pin 3 (black). The reading should be approximately -5 VDC. If your readings do not equal these, replace the batteries (see "To Replace Batteries" section below).

To Replace Batteries:

1. Loosen the screws indicated on the back panel of the MAX 5.

2. Remove the upper and lower screws on the outside of the MAX 5 housing and remove both panels of the MAX 5. Disconnect J2 from the analog PCB (smaller PCB assy.).

3. Remove the screw holding the battery pack in place. Carefully lift out the battery pack.

4. Remove the tape and plate holding the existing batteries in place. Replace the batteries with new Nickel-Cadmium rechargeable batteries.

5. Tape the new batteries in place and replace the plate. Insert the battery pack in the MAX 5 and screw it in place. Reconnect J2 to analog PCB. Put on the bottom of the case, insert and tighten the screws on the sides and tighten the screws in the back of the MAX 5.

SENSOR REPLACEMENT

When the sensor's (CO, Gomb., and O2) near the end of their useful life, sensitivity will decline rapidly and the readings will be very unstable. Refer to "Operator's Checks & Adjustment" - Messages and Failure Warning Signs for further details. For sensor replacement, refer to "Installation Procedures."

AFTER REPLACING ANY SENSOR, PROCEED TO THE "INSTRUMENT OPERATING PROCEDURE" SECTION FOR CALIBRATION.

Important: To avoid the possibility of not having a replacement cell available when it is needed, Teledyne recommends that a spare cell be ordered shortly after the instrument is placed in service, and each time the cell is replaced thereafter.

Caution: DO NOT OVER ORDER (OR STOCK-PILE) SPARE CELLS. Only one cell per instrument should be in reserve.

OPERATOR'S CHECKS & ADJUSTMENTS

MESSAGES

This section describes messages that may appear on the MAX 5 LCD so that you can correct the problem.

-0.0 Indicates a negative reading. A bad sensor, a downward shift in zero calibration since the last adjustment, or an improper calibration might produce this error message. REMEDY: Recalibrate the instrument.

-0.00/-0.0 The negative sign in a reading of -0.00 or -0.0 in the CO or COMB section after auto zero is not significant.

bAd Indicates a bad reading from the cell. If the cell is outside its specifications or is noisy and unstable, the computer cannot get a good reading, and the calibration adjustment required to compensate may be greater than the maximum allowable adjustment, resulting in this error message. REMEDY: Recalibrate the instrument or replace the cell.

CELL FAIL Means that a cell has failed or that a problem has occurred in a sensor circuit. REMEDY: Isolate the faulty sensor circuit, replace the bad sensor, or rectify the circuit problem, as necessary. Example: Thermocouple is not connected.

--- Means that the value cannot be calculated. If the thermocouple is disconnected, for example, then the computer cannot perform the efficiency calculation (which depends on temperature data), and this error may occur; the efficiency reading will be ---, and the temperature reading will be OPt.

OFF Means off-scale for CO reading.

LO BATT Indicates the batteries are depleted or near depletion after about 8 hours use. REMEDY: Recharge the batteries.

FAILURE WARNING SIGNS

The MAX 5 indicates failure warning signs with a CELL FAIL message on the LCD and a bAd reading.

O2 The cell output is low which results in too high a span requirement.

CO The inability to span or excessive noise indicate cell failure.

COMB. Excessive drift and the inability to span or zero indicate cell failure.

TEMP. A failure message on the temperature section indicates an open or short thermocouple circuit.

CO2 Conditions that contribute to failure or erroneous reporting of the carbon dioxide section include failure of any of the other sensors or incorrect fuel selection.

OPt Open thermocouple or optional temperature simulation (Refer to "Temperature Simulation" section).

APPENDIX

TO PRINT STORED READINGS (KEY 5) – OPTIONAL

1. On the back of the instrument is a "serial output" receptacle for connection to a serial (RS-232C) printer (see Note). The RS-232C data output format is as follows: 1 start bit, 8 data bits, and 1 stop bit, at a rate of 300 baud (bits/sec.). A connecting cable is available from TAI when using a standard serial printer with the analyzer. To use the printer, proceed as follows:

Plug the cable into the MAX 5 "serial output" receptacle and the printer (see Figure 3).

Align the paper.

Turn the power on.

Press the "FF(Form Feed)/Auto Sheet Load" button to advance the paper one sheet.

Press the "ONLINE" button.

NOTE: If the printer is purchased from TAI, refer to the printer "Instruction manual" for set up. If the printer is not purchased from TAI, any serial printer may be used if it complies with the following minimum specifications:

a. It can accept RS-232C serial data in the speed and format shown.
b. It has a standard 25 pin RS-232C connector, so it can be used with the optional factory-supplied cord.
c. It has a minimum print speed of 50 characters per second (cps).
d. It has an input buffer of at least 1024 bytes (1Kb).

MATERIAL SAFETY DATA SHEET

Section I - Product Identification

Product Name: Micro Fuel Cells, all classes except A-2, A-3, A-5, B-2F and B-2CF.
Electrochemical Oxygen Sensors, all classes except R-19.
Mini micro-fuel cells, all classes.

Manufacturer: Teledyne Analytical Instruments

Address: 16830 Chestnut Street, City of Industry, CA 91749

Phone Number: (818) 961-9221

MSDS Prepared By: Chuck Molloy

Date Prepared or Last Revised: 3-31-88

Emergency Phone Number: (818) 961-9221

Section II - Physical and Chemical Data

Chemical and Common Names: Potassium Hydroxide (KOH) 15%
Granular Lead (Pb) pure

CAS Number: KOH 1310-58-3
Pb 7439-92-1

Melting Point/Range: -10 to 0 deg. C

Boiling Point/Range: 100 to 115 deg. C

Specific Gravity: 1.09 @ 20 deg. C

pH: >14

Solubility in Water: Completely soluble

Percent Volatiles by Volume: None

Appearance and Odor: Colorless, odorless solution

Section III - Physical Hazards

Potential for Fire and Explosion: The eletrolyte in micro-fuel cells is not flammable. There are no fire or explosion hazards associated with micro-fuel cells.

Potential for Reactivity: The sensors are stable under normal conditions of use. Avoid contact between the sensor electrolyte and strong acids.

Section IV - Health Hazard Data

Primary Route(s) of Entry: Ingestion, Eye/Skin Contact

Exposure Limits: OSHA PEL .05 mg/cu.m. (Pb)
ACGIH TLV 2 mg/cu.m. (KOH)

Effects of Overexposure:

Ingestion: The electrolyte could be harmful or fatal if swallowed.
Oral LD50 (RAT) = 2433 mg/kg

Eye: The electrolyte is corrosive and eye contact could result in permanent loss of vision.

Dermal: The electrolyte is corrosive and skin contact could result in a chemical burn.

Inhalation: Liquid inhalation is unlikely.

Signs/Symptoms of Exposure: Contact with skin or eyes will cause a burning sensation and/or a soapy feeling for skin contact.

Medical Conditions Aggravated by Exposure: None

Carcinogenicity:

NTP Annual Report on Carcinogens: Not listed.

LARC Monographs: Not listed.

OSHA: Not listed.

Other Health Hazards: Lead is listed a chemical known to the State of California to cause birth defects or other reproductive harm.

Section V - Emergency and First Aid Procedures

Eye Contact: Flush eyes with water for at least 15 minutes and get immediate medical attention.

Skin Contact: Wash affected area with plenty of water and remove contaminated clothing. If burning persists, seek medical attention.

Ingestion: Give plenty of cold water. Do not induce vomiting. Get medical attention.

Inhalation: Liquid inhalation is unlikely.

Section VI - Handling Information

Handling Precautions: Note: The oxygen sensors are sealed and under normal circumstances, the contents of the sensors do not present a health hazard. The following information is given as a guide in the event that a cell leaks.

Protective Clothing: Rubber gloves, chemical splash goggles.

Clean-up Procedures: Wipe down the area several times with a wet paper towel. Use a fresh towel each time.

Protective Measures during Cell Replacement: Before opening the bag containing the cell, check the cell for leakage. If the cell leaks, do not open the bag. If there is liquid around the cell while in the instrument, put on gloves and eye protection before removing the cell.

Disposal: Should be in accordance with all applicable state, local and federal regulations.

MATERIAL SAFETY DATA SHEET

Section I - Product Identification

Product Name: Carbon Monoxide Sensor, Class F-1R, F-1RH and F-2

Manufacturer: Teledyne Analytical Instruments

Address: 16830 Chestnut Street, City of Industry, CA 91749

Phone Number: (818) 961-9221

MSDS Prepared By: Chuck Molloy

Date Prepared or Last Revised: 3-31-88

Emergency Phone Number: (818) 961-9221

Section II - Physical and Chemical Data

Chemical and Common Names: Sulfuric Acid (H_2SO_4) 17%
Silica (SiO_2) 50%

CAS Number: H_2SO_4 7664-93-9
SiO_2 7631-86-9

Melting Point/Range: 1700 deg. C

Boiling Point/Range: N/A

Specific Gravity: 2.2 @ 20 deg. C

pH: Less than 1

Solubility in Water: Insoluble

Percent Volatiles by Volume: None

Appearance and Odor: White powder with an irritating odor.

Section III - Physical Hazards

Potential for Fire and Explosion: The eletrolyte in carbon monoxide sensors is not flammable. There are no fire or explosion hazards associated with carbon monoxide sensors.

Potential for Reactivity: The sensors are stable under normal conditions of use. Avoid contact between the sensor electrolyte and strong acids, strong bases, strong oxidizers and reducers.

Section IV - Health Hazard Data

Primary Route(s) of Entry: Ingestion, Eye/Skin Contact

Exposure Limits: OSHA PEL N/A
ACGIH TLV 1 mg/cu.m. (H_2SO_4)
10 mg/cu.m. (Total Dust)
5 mg/cu.m. Respirable Dust (SiO_2)

Effects of Overexposure:

Ingestion: The electrolyte could be harmful or fatal if swallowed.
Oral LD50 (RAT) = 2433 mg/kg

Eye: The electrolyte is corrosive and eye contact could result in permanent loss of vision.

Dermal: The electrolyte is corrosive and skin contact could result in a chemical burn.

Inhalation: Solid inhalation is unlikely.

Signs/Symptoms of Exposure: Contact with skin or eyes will cause a burning sensation.

Medical Conditions Aggravated by Exposure: None

Carcinogenicity:

NTP Annual Report on Carcinogens: Not listed.

LARC Monographs: Not listed.

OSHA: Not listed.

Other Health Hazards: None.

Section V - Emergency and First Aid Procedures

Eye Contact: Flush eyes with water for at least 15 minutes and get immediate medical attention.

Skin Contact: Wash affected area with plenty of water and remove contaminated clothing. If burning persists, seek medical attention.

Ingestion: Give plenty of cold water. Do not induce vomiting. Get medical attention.

Inhalation: Solid inhalation is unlikely.

Section VI - Handling Information

Handling Precautions: Note: The carbon monoxide sensors are sealed and under normal circumstances, the contents of the sensors do not present a health hazard. The following information is given as a guide in the event that a cell leaks.

Protective Clothing: Rubber gloves, chemical splash goggles.

Clean-up Procedures: Wipe down the area several times with a wet paper towel. Use a fresh towel each time.

Protective Measures during Cell Replacement: Before opening the bag containing the cell, check the cell for leakage. If the cell leaks, do not open the bag. If there is liquid around the cell while in the instrument, put on gloves and eye protection before removing the cell.

Disposal: Should be in accordance with all applicable state, local and federal regulations.

{file maxmsds.c.txt}

ANALYTICAL INSTRUMENTS | MATERIAL SAFETY DATA SHEET | P.O. BOX 80434 ATLANTA, GA 30366

I PRODUCT IDENTIFICATION

A. Product Name: PURAFIL MEDIA

B. Manufacturer: PURAFIL, INC.

E. Chemical Name (s) & Molecular Formula (s) Give Specific IUPAC Name (s):
POTASSIUM PERMANGANATE/ALUMINIUM OXIDE
$KMnO_4$ + AL_2O_3 + H_2O

D. Emergency Phone Number (s): Business 404-451-7146; Other

G. CAS No. (s): 7722-64-7

F. Synonyms: PURAFIL II CHEMISORBANT, PURAFIL FS CHEMISORBANT

H. Chemical Family: INORGANIC OXIDIZER

II SPECIFIC GENERIC INGREDIENTS

A. MATERIALS OR COMPONENTS (Include all carcinogens at levels ≥ 0.1% and all other ingredients at levels ≥ 1.0%)	B. % w/w	C. CASN	D. HAZARD DATA (TLV LD50 LC50 etc.)
POTASSIUM PERMANGANATE		4-6	N/A

III GENERAL REQUIREMENTS

A. Use: AS SCRUBBER IN ANALYZER TO REMOVE INTERFERING GASES

B. Handling: AVOID SKIN CONTACT, RUBBER GLOVE RECOMMENDED

C. Storage: STORE IN COOL DRY AREA IN CLOSED CONTAINERS

IV PHYSICAL PROPERTIES

A. Boiling Point/Range	B. Melting Point	C. Freezing Point	D. Molecular Weight (Calculated)
N/A	N/A	N/A	MIXTURE

E. Specific Gravity	F. Vapor Pressure (mm Hg)	G. Vapor Density (Air = 1)	H. pH
APPROX. 0.7	N/A	N/A	N/A

I. Solubility in H_2O: PARTIALLY SOLUBLE

J. % Volatiles by Volume: 8 - 14%

K. Evaporation Rate: ☐ Ether ≥ 1 ☐ Water ≥ 1 N/A ☐ Butylacetate ≥ 1

L. Appearance and Odor: SPHERICAL PURPLE PELLETS

M. Other: N/A

V FIRE AND EXPLOSION DATA

A. Flash Point	Test Method	B. Flammable Limits	C. Autoignition Temperature/Fire Point
N/A		Lower N/A Upper N/A	N/A

D. EXTINGUISHING MEDIA
☐ Water-spray ☐ Water-fog ☐ Water stream ☐ CO_2 ☐ Dry chemical ☐ Alcohol foam ☐ Foam ☐ Earth or sand

E. SPECIAL FIRE FIGHTING PROCEDURES
☐ Do not enter building ☐ Allow fire to burn ☐ Water may cause frothing ☐ Do not use water ☐ None NON-FLAMMABLE

F. UNUSUAL FIRE AND EXPLOSION HAZARDS
☐ Dust explosion hazard ☐ Sensitive to shock ☐ Contamination ☐ Temperature ☐ None ☐ Other (specify)

VI REACTIVITY DATA

A. STABILITY
☒ Stable ☐ Unstable

B. CONDITIONS CONTRIBUTING TO INSTABILITY
☐ Thermal decomposition ☐ Photo degradation ☐ Polymerization ☐ Contamination ☒ None

C. INCOMPATIBILITY – Avoid contact with
☒ Strong acids ☒ Strong alkalis ☒ Strong oxidizers ☒ Reducers ☒ Water ☐ None ☒ Other (specify) CONTAMINATED AIR

D. HAZARDOUS DECOMPOSITION PRODUCTS – THERMAL AND OTHER (list)
DILUTE $KMnO_4$ SOLUTION WHEN WETTED

E. CONDITIONS TO AVOID
☐ Heat ☐ Open flames ☐ Sparks ☐ Ignition sources ☒ None ☐ Other (specify)

VIII SPILL OR LEAK

A. STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
☐ Flush with water ☐ Absorb with sand or inert material ☐ Neutralize ☒ Sweep or scoop up and remove ☐ Keep upwind Evacuate enclosed spaces ☐ Prevent spread or spill ☐ Dispose of immediately ☐ Other (specify)

B. WASTE DISPOSAL METHOD (Specific)
MATERIAL SHOULD BE DISPOSED ACCORDING TO LOCAL, STATE & FEDERAL REGULATION

VIII HEALTH HAZARD INFORMATION

A. PRIMARY ROUTE(S) OF ENTRY:
☐ Skin absorption ☒ Inhalation ☒ Ingestion

B. EXPOSURE LIMITS (Specify if TLV/TWA, Ceiling (c), PEL, etc.)
ACGIH 1B _____ OSHA 1B _____ Other N/A

Effects of Exposure

C. INGESTION
Acute:
Chronic:

D. DERMAL
Acute ☐ Irritant ☐ Corrosive ☐ Sensitizer ☐ Defatter ☒ None ☐ Other _____
Chronic ☐ Irritant ☐ Corrosive ☐ Sensitizer ☐ Defatter ☒ None ☐ Other _____

E. EYE
Acute ☒ Severe irritant ☐ Mild irritant ☒ Corrosive ☐ None ☐ Other _____
Chronic ☐ Severe irritant ☐ Mild irritant ☐ Corrosive ☐ None ☐ Other _____

F. INHALATION
Acute ☒ Irritant ☐ Allergen ☐ Asphyxiant ☐ Sensitizer ☐ Edema ☐ None
☐ Narcotic effect ☐ Cyanosis ☐ Other _____
Chronic ☐ Irritant ☐ Allergen ☐ Sensitizer ☐ Carcinogen ☒ None ☐ Other _____

G. SYSTEMIC
Acute: Specific effect(s)
Chronic: Specific effect(s) N/A

H. OTHER TOXIC EFFECTS (include Aquatic Toxicity and no effect level)
N/A

IX EMERGENCY FIRST AID

A. INGESTION
☐ Induce vomiting ☐ DO NOT induce vomiting ☐ Give plenty of water ☐ Get medical attention ☒ No ill effects ☐ Other (specify)

B. SKIN CONTACT
☐ No ill eff. or injury expected ☐ Wash area remove contaminated clothing immediately ☒ Wash area remove garment within reasonable time ☐ Flush area remove clothing immediately ☐ Report to Medical Dept.

C. EYE CONTACT
☒ Flush with plenty of water for at least 15 MINUTES ☒ Get medical attention ☐ No ill effects ☐ Other (specify)

D. INHALATION
☒ Remove to fresh air ☐ If not breathing provide appropriate life support ☐ Give oxygen ☐ Get medical attention ☐ No ill effects ☐ Other (specify)

X SPECIAL PROTECTION INFORMATION

A. VENTILATION REQUIRMENTS– Always maintain exposure below permissible exposure limits
☐ Consult an industrial hygienist or environmental health specialist ☐ Local exhaust ☒ Use with adequate ventilation ☐ Check for air contaminant and oxygen deficiency
☐ Store in well ventilated area ☐ None required ☐ Other (specify)

B. EYE ☐ Face shield ☒ Safety glasses ☒ Goggles

C. HAND (GLOVE TYPE) ☒ Butyl rubber ☒ Polyvinyl alcohol ☐ Cloth ☐ Leather
☒ Polyvinyl Chloride ☒ Neoprene ☒ Natural rubber ☒ Poly-ethylene ☐ Other (specify)

D. RESPIRATOR TYPE – Use only NIOSH/MESA approved equipment
☐ Self-contained ☐ Supplied air ☐ Can or cartridge gas or vapor ☒ Filter – dust fume mist ☐ Other (specify)

E. OTHER PROTECTIVE EQUIPMENT
☐ Rubber boots ☐ Apron ☐ Other (specify)

XI SPECIAL PRECAUTIONS

A. PRECAUTIONS
☒ Wash thoroughly after handling ☒ Do not get in eyes on skin or clothing ☒ Do not breathe dust vapor mist gas ☒ Keep container closed ☒ Keep away from heat sparks and open flames ☒ Store in tightly closed containers
☐ Do not store near combustibles ☒ Keep from contact with clothing and other combustible materials ☐ Empty container may contain hazardous residues ☐ Use explosion proof equipment ☐ Other (specify)

B. TRANSPORATION & OTHER PRECAUTIONS
DOT PROPER SHIPPING NAME NMFC13090 ALUMINA

Prepared by KAI CHIU Date 10-6-89 Address 16830 CHESTNUT ST. CITY OF INDUSTRY CA 91749-1580 Phone 818-961-9221

Updated 10-6-89

RECOMMENDED SPARE PARTS LIST

MAX 5 MONITOR

QTY	P/N	DESCRIPTION
1	C-6689-B3	MICRO-FUEL CELL - OXYGEN SENSOR
1	C-40371-F1R	ELECTROCHEMICAL SENSOR - CARBON MONOXIDE
1	A-39202A	COMBUSTIBLE PROBE/CABLE
1	B-39764A	PROBE GUN ASSEMBLY (TYPE "K" HI TEMP. THERMOCOUPLE)
1	B-39764B	PROBE GUN ASSEMBLY (TYPE "J" LO TEMP. THERMOCOUPLE)
1*	D-38370A	PC BOARD ASSEMBLY - ANALOG (TYPE "K" THERMOCOUPLE)
1*	D-38370B	PC BOARD ASSEMBLY - ANALOG (TYPE "J" THERMOCOUPLE)
1*	D-38584A	PC BOARD ASSEMBLY - MICROPROCESSOR
1	L-182	LCD DISPLAY
10	F-6	FUSES, 3AG-1/4 A
5	B-71	NICAD BATTERIES
1	C-964	POWER CORD
1	A-39207A	PUMP
1	F-273	SAMPLE FLOWMETER
1	F-274	AIR FLOWMETER
1	B-25900	SCRUBBER
1	A-13455	FILTER ELEMENT
1	F-513	FILTER ASSY
1	A-40688	CAL KIT FOR 0-1000 PPM;Replacement Cal Gas G-222
1	A-48231	CAL KIT FOR 0-1% CO;Replacement Cal Gas G-41 & G-259(CO)
1	A-48232	CAL KIT FOR 0-2% CO;Replacement Cal Gas G-41 & G-162(CO)
1	C-967	CARRYING CASE (MAX)
1	P-528	PRINTER
1	I-106	INTERFACE for printer
1	A-40342	PRINTER CABLE ASSEMBLY (for printer)
1	T-823	TRANSFORMER (used w/printer for 220V application only)

* Specify CO range when ordering.

A MINIMUM CHARGE OF $15.00 IS APPLICABLE TO SPARE PARTS ORDERS.

IMPORTANT: Orders for replacement parts should include the part number (if available) and the model and serial number of the system for which the parts are intended.

SEND ORDERS TO:

TELEDYNE ANALYTICAL INSTRUMENTS
16830 CHESTNUT STREET
CITY OF INDUSTRY, CALIF., 91748
TELEPHONE (818) 961-9221
EASY LINK 628-31862
(OR YOUR LOCAL REPRESENTATIVE)

REFERENCE DRAWINGS

MAX 5 MONITOR

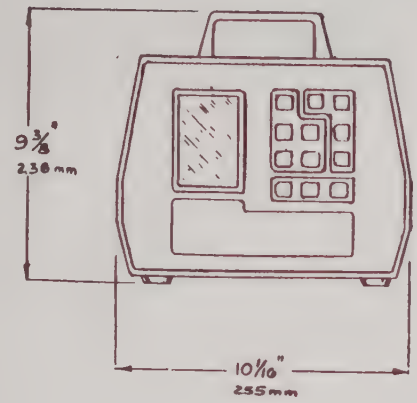
INSTALLATION DRAWINGS

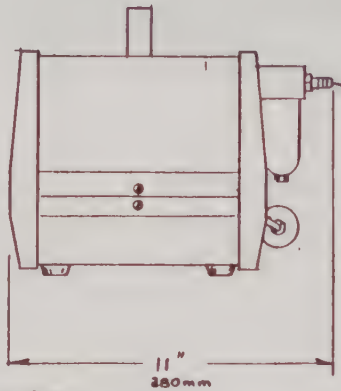
B-39437	OUTLINE DIAGRAM
B-39430	PIPING DIAGRAM (STANDARD)
B-43108RF	PIPING DIAGRAM (%CO) (OPTIONAL)
C-39776	CONNECTION DIAGRAM

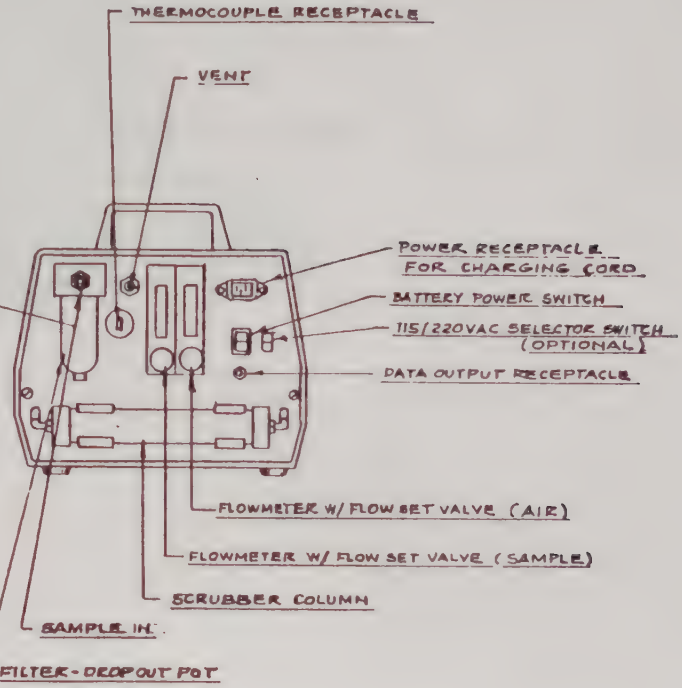
ASSEMBLY DRAWING

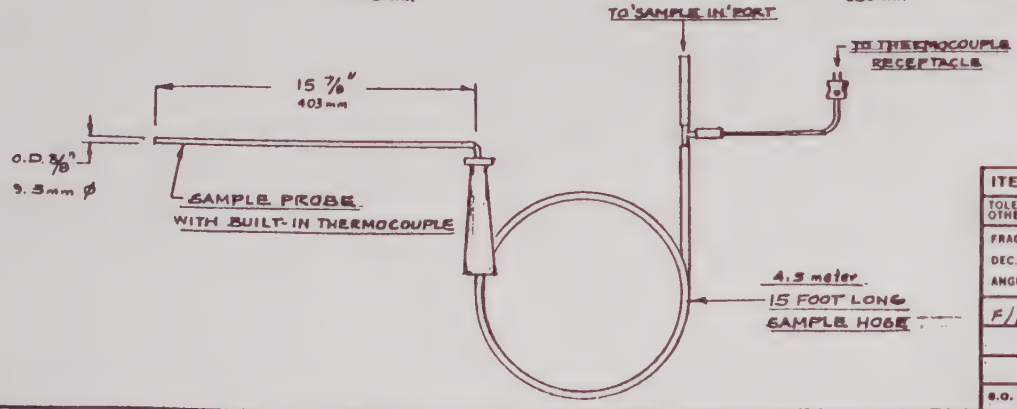
A-40342	ASSEMBLY – PRINTER CABLE

QA	ISSUE NO.	DATE	REVISION / ECO NUMBER	APP
	1.	6-13-86		
	2	11-6-86	ECO #06-0181	









ITEM	PART NO.	REQ	DESCRIPTION

TOLERANCE UNLESS OTHERWISE SPECIFIED
FRAC. ± 1/64"
DEC. ± .005"
ANGULAR ± 1/2°

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ANALYTICAL INSTRUMENTS
CITY OF INDUSTRY, CALIFORNIA 91748

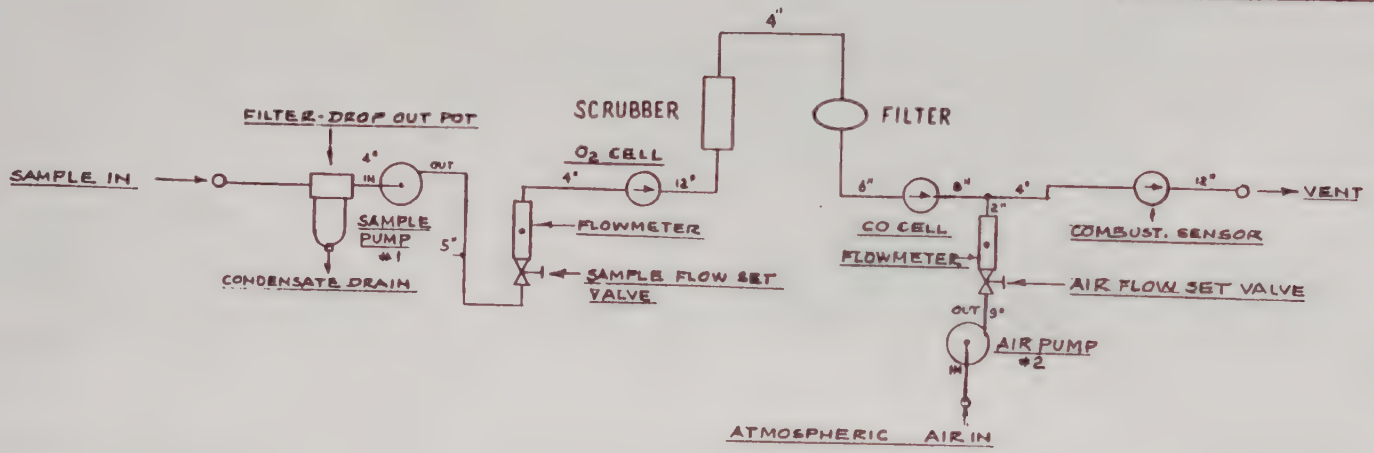
SCALE — DATE 12-20-8
MAT'L —
FINISH —
DR 9 ENGR RDO APP

F/D-39218
S.O. -

OUTLINE DIAGRAM
MAX 5 , MONITOR

B-39437

QA	ISSUE NO.	DATE	REVISION / ECO NUMBER	APP
	1.	12-19-85		
	2.	6-18-86		
	3.	1-30 87	ECO # 87-0009	



ITEM	PART NO.	REQ	DESCRIPTION

TOLERANCE UNLESS OTHERWISE SPECIFIED
FRAC. ± 1/64"
DEC. ± .005"
ANGULAR ± 1/2°

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CITY OF INDUSTRY, CALIFORNIA 91748

SCALE —— DATE 12-19-85
MAT'L —
FINISH —
DR [illegible] ENGR [illegible] APP [illegible]

F/O-37218

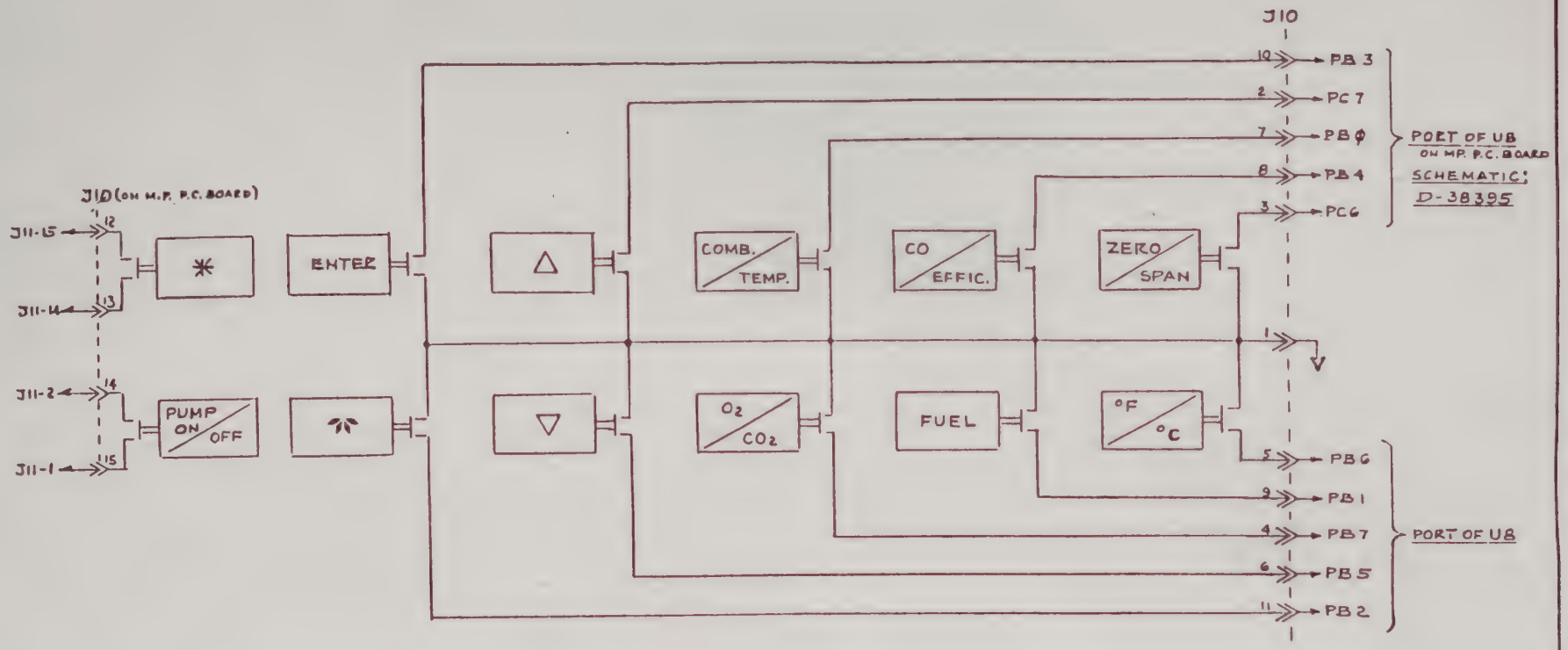
PIPING SCHEMATIC
MAX5 MONITOR

B- 30130

S.O.

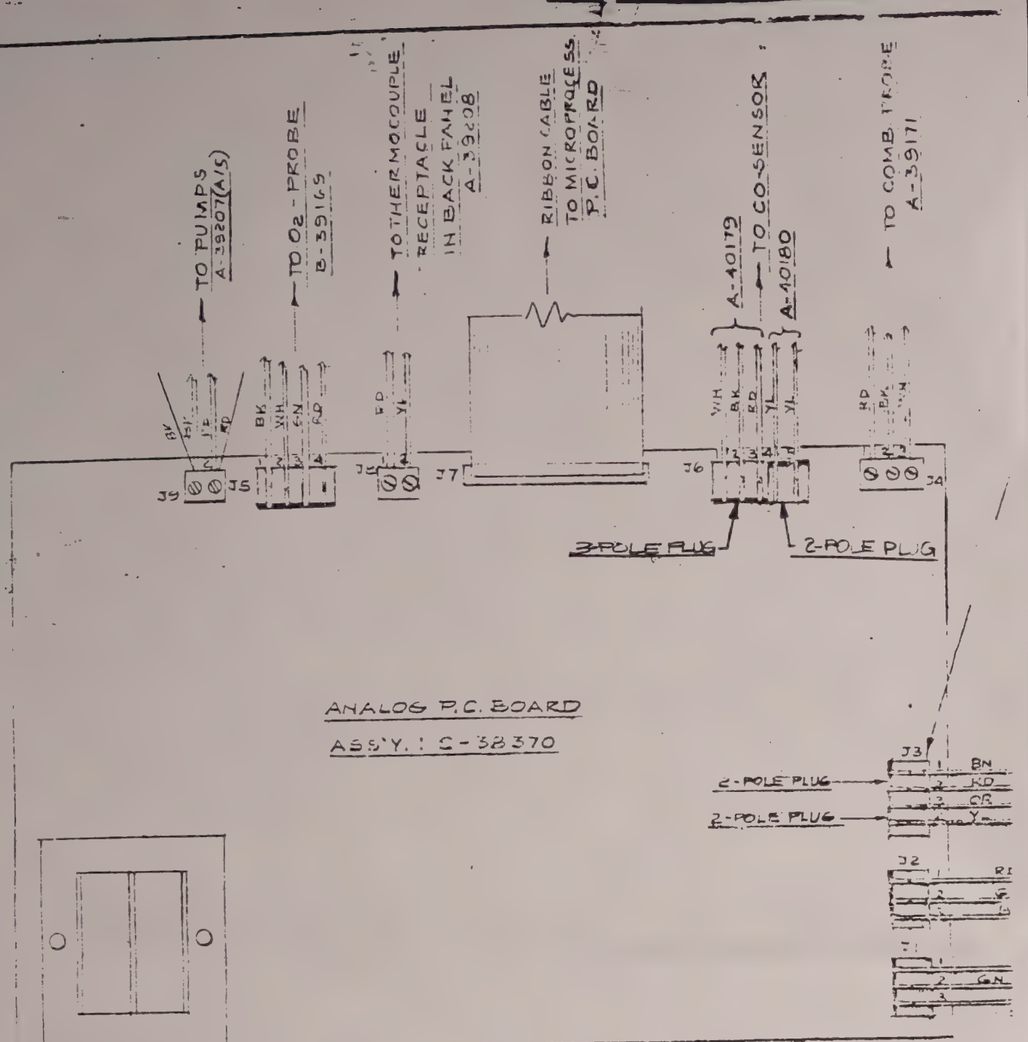
BISHOP GRAPHICS/ACCUPRESS

QA	ISSUE NO.	DATE	REVISION / ECO NUMBER	APP
	1.	6-13-86		



ITEM	PART NO.	REQ	DESCRIPTION
TOLERANCE UNLESS OTHERWISE SPECIFIED			THIS DRAWING IS THE PROPERTY OF TELEDYNE ANALYTICAL INSTRUMENTS AND CONTAINS CONFIDENTIAL INFORMAT... IT IS NOT TO BE COPIED, REPRODUCED OR USED WITHOUT WRITTEN PERMISSION
FRAC ± 1/64"			TELEDYNE ANALYTICAL INSTRUMENTS
DEC ± .005"			CITY OF INDUSTRY, CALIFORNIA 91748
ANGULAR ± 1/2°			SCALE — DATE 3-25-86
N/D-39218			SCHEMATIC
A/C-41806			KEYBOARD
			"MAX" MONITOR
P.O.			MAT'L — FINISH —
			DR ENGR APP
			B-40163

QA	ISSUE NO.	DATE	REVISION / ECO NUMBER	APP
	1.	6/13/86		
	2.	6-25-86	ECO 86-0108	
	3.	11-30-89	ECO 89-0182	



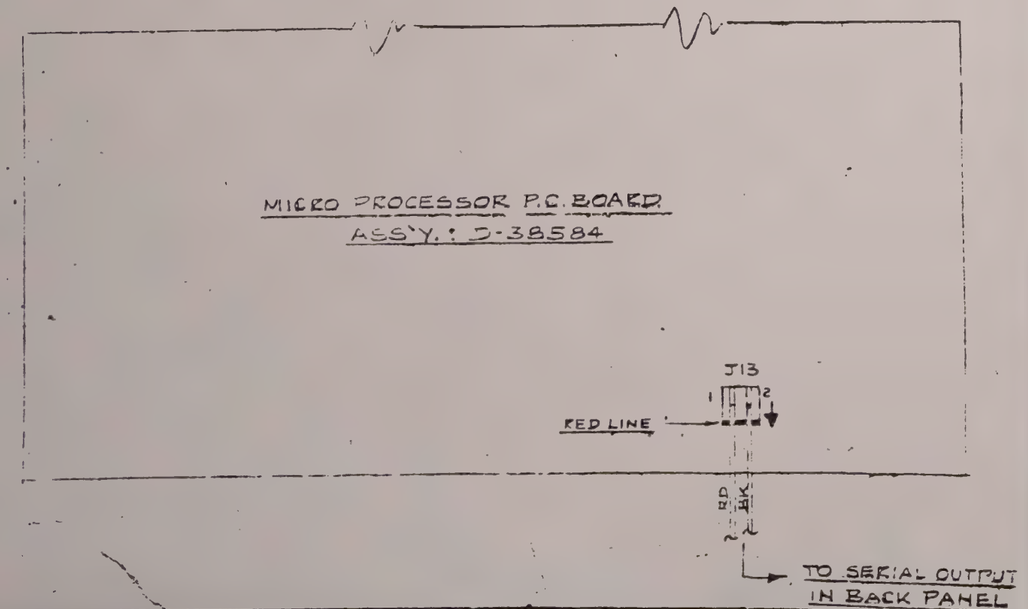
ANALOG P.C. BOARD
ASS'Y.: C-38370

→ TO OFF/ON SWITCH
IN BACK PANEL
A-39205

→ TO BATTERY PACK
B-39164

→ TO POWER RECEPTACLE
IN BACK PANEL
A-39206

RETAINER (TYP.)



RECEPTACLE
A-39752

ITEM	PART NO.	REQ	DESCRIPTION

TOLERANCE UNLESS OTHERWISE SPECIFIED
FRAC ± 1/64"
DEC ± .005"
ANGULAR ± 1/2°

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ANALYTICAL INSTRUMENTS
CITY OF INDUSTRY, CALIFORNIA 91748

SCALE — DATE 2-12-86
MAT'L
FINISH
DR | ENGR HPW | APP.

F/D-39218

CONNECTION DIAGRAM
"MAX" MONITOR

C-39776

B.O.

BISHOP GRAPHICS/ACCUPRESS

ISSUE NO.	DATE	REVISION / ECO NUMBER	APP.
10	5-24-84	ECO # 83-0098	[illegible]
11	11-13-90	ECO # 90-0378	[illegible]
12	3-8-91	ECO # 91-0093	[illegible]
13	3-19-92	ECO # 92-042	[illegible]

CARBONMONOXIDE

CO-SENSOR

J6

R3, 213K, .1% ZD1 IN935A 9.3V

-REF. (-1.24V)

R1, 8.25K

TH. 16K @ 25°C

R2 1.21M 1MF

R42 2.15 M

C1 .10MF

R4 11K .1%

-1.24 V

C2 2.2MF

ZD3 LM385

R5 100K TRIM ~75K

R6 309K

R7 5.9K

U1C LM346 1/4

U1B LM346 1/4

R40 24.9K .1%

U1A LM346 1/4

TP

R13 11.5K

TP1

-5V, UNSW.

J7-7 → CH 6 J11-7

TP3

D12 IN4004

R9 1M

R10 1M

R8 22M

D5 IN4148 +7.5V, SW.

R11 22M

-5V, UNSW.

OXYGEN

R18, 1M

C4 10MF

R14, 10K

R15, 261K

+15V SW.

TP9

D6 IN4148 +7.5V, UNSW.

D9 +15V, SW

J5

RD 4

BK 1

WH 2

O2 CELL (.83-.210)

371Ω 25°C TH. 3

R16 909Ω

R17 90.9Ω

OP07 U4

-5V, SW.

TP10

J7-6 → CH1, J11-6

TP11

D11 IN4004

COMBUSTIBLES

+5V, SW

COMBUSTIBLE SENSOR

J4

P2 10K ZERO

R12 1K

R19 499Ω

R20 499Ω

R21X

R38

.1Ω, 2W .1%

SENSOR CURRENT IN mVDC

C6 10MF

R22 2K

R23 49.9K

TP14

TP15

U1D LM346 1/4

P5 10K SPAN

J7 B → CH2, J11-8

D10 IN4004

C7 1MF

P6 50Ω 20T CURRENT ADJ.

R21 5Ω ±1% 1W

R24 750Ω

R25 49.9K

VR1 LM337T

ADJ OUT IN

1 uf

-5V, SW

TEMP. SENSOR

+5V, SW

ZD11 IN746A 3.6V

R27 10K

TP6

J7 4 → TO US-12 M.P. PC BD THERMOCOUPLE FAIL ACTIV. LO

J8

RD (-)

YL (+)

.001MF C30

U3 AD 597 TYPE K AD 595 TYPE J

+15V, SW

C8 .01MF

THERMOCOUPLE

TYPE K STD

TYPE J OPTIONAL

R30 2K .1%

TP7

J7 5 → CH3 J11-5

R29 1.33K .1%

C9 1MF

PUMP CONTROL

SPACE LEADS

+5V SW → OD

+7.5V SW → OC

HMS 53V

AIR PUMP MOTOR

J9-2

J9-1

R34, 4.75K

C16 1MF 53V

SNAP PUMP MOTOR

Q1 2N7000

R33 1K

TP16

74HC14

U2

R35 221K

ZD8 IN935 9.3V

C9 .001MF

TP17 C18 0.1MF

-5V, SW

-5V, GW

Q2 2N7000

5V SW

Q3 (OPT.)

74HC14

-5V, SW

-REF

TP5

R37 20K

-1.24V

LM385 ZD4

-5V SW

+5V SW

VR2 CB 3802

C10 22MF 35V

C11 22MF 35V

TP8

J7 3 → +15V J11-3 SW

+15V SW

J7 → J11-10 +5V/+3V BATT. BACK-UP

+5V, SW

D7 1N5819

TP12

D8

+7.5V, UNSW

R41 12.4K

+3.7V

ZD6 LM385 1.2V

ZD7 LM385 2.5V

NOTE: C12 & C13 PRESENTLY NOT INSTALLED.

C13

C12

VR4 LM7805

C14 0.1MF

C15 0.1MF

+5V, SW

TP13

J7 12 → J11-13 +5V SW

11 +7.5V SW → J11-11 J7

J3

BK

RD 2

OR 3

YL 4

SW1

-5V, SW

13 J11-13 -5V, SW J7

CHARGING CURRENT IN mVDC.

3Ω, 1W

VR3 LM317T

R31 R31X

R39 .1Ω 2W

J1

F1

MOV2

MOV1

D1 D2 D3 D4 IN4004

T1

C20 2200MF 40V

BATTERIES

7.6V

J2

J1-2

J1-9

J1-16

-5V, UNSW.

*115V { A TO D / B TO C

*220V C TO D

A.C. POWER IN

POWER SUPPLY

ITEM	PART NO.	REV	DESCRIPTION
	N/O-39218		
	A/O-38370		

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TOLERANCE UNLESS OTHERWISE SPECIFIED
FRAC = 1/64"
DEC = .005"
ANGULAR = 1/2°
6.0

TELEDYNE ANALYTICAL INSTRUMENTS
CITY OF INDUSTRY CALIFORNIA 91749

SCHEMATIC
ANALOG P.C BOARD
"MAX" MONITOR

SCALE — DATE 3-25-86
MAT'L —
FINISH —
DR V.C. ENGR APP.

C-40162

FORMS GRAPHICS ACCUPRESS
REORDER NO A22479

MP MASTER
MA22001

TELEDYNE ANALYTICAL INSTRUMENTS

Sensors • Analyzers • Systems

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